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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/528,556	10/05/2005	Yasuyuki Sakaguchi	Q72116	6382

23373 7590 07/12/2007

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EXAMINER	
MALEKZADEH, SEYED MASOUD	
ART UNIT	**PAPER NUMBER**
1722	
MAIL DATE	**DELIVERY MODE**
07/12/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/528,556	SAKAGUCHI ET AL.	
	Examiner	Art Unit	
	SEYED MASOUD MALEKZADEH	1722	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *27 April 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3,5-13 and 15-18* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3,5-13 and 15* is/are rejected.

7)☒ Claim(s) *16-18* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 March 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *See Continuation Sheet*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Continuation of Attachment(s) 3). Information Disclosure Statement(s) (PTO/SB/08), Paper No(s)/Mail Date :03/21/2005, 10/05/2006, 12/27/2006, 04/27/2007.

DETAILED ACTION

Response to Amendment

Claims 1, 3, 5-13, and 15-18 are pending.

In view of amendment, filed on April 27, 2007 following rejections/objections are withdrawn for the reasons of record.

- ✓ Objection of claims 3 since applicants have amended the claims to delete the reference numerals and claim 4 is canceled.
- ✓ Rejection of claims 2, 4, and 14 since applicants has deleted claims 2, 4, and 14.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 13, 15 are rejected under 35 U.S.C. 102(b) as being anticipated by Davis et al. (US 4,886,005)

Davis et al. ('005) teach an apparatus for producing a silicon carbide single crystal having a graphite-made growth crucible (See lines 49-50, column 5) with a low temperature section and a high temperature section wherein a seed crystal substrate formed of silicon carbide single crystal placed in the low temperature section and a

silicon carbide raw material placed in the high temperature section (See lines 56-68 column 8; lines 1-12 and lines 31-38 column 9).

Further Davis et al. ('005) teach disclose the porous graphite liner is formed in such a manner as to provide an annular chamber between lower portions of the porous graphite liner, the crucible walls and the crucible lid. A central sublimation chamber is also showed (See lines 55-60, column 5 and Figure 1). Therefore, the growth crucible has a lid and is provided therein with a supporter having a lower surface to which the seed crystal substrate is to be attached, with a space left between an upper surface of the supporter and the lid of the growth crucible.

Moreover, Davis et al. ('005) discloses an outer crucible (14) disposed to surround the growth crucible (20), with a space left there between. (See figure 1)

Further, Davis et al. ('005) discloses the apparatus include metered feeding. (See lines 33-35, column 6 and lines 62-68, column 11)

The prior art, thus, meet all the claim limitations, and therefore, Davis et al. ('005) anticipate the claims 13, 15.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Davis et al (US 4,866,005) in view of Hung Chi Chang et al (US 3,275,415) and further in view of Shiomi et al (US 6,193,797)

Davis et al ('005) teach a method for producing a silicon carbide single crystal, having the steps of providing a graphite-made growth crucible (See lines 49-50, column 5) with a low temperature section and a high temperature section, and placing a seed crystal substrate formed of silicon carbide single crystal in the low temperature section of the growth crucible and placing a silicon carbide raw material in the high-temperature section of the growth crucible and depositing a gas sublimed from the silicon carbide raw material onto the seed crystal substrate to thereby grow a silicon carbide single crystal (See lines 56-68 column 8; lines 1-12 and lines 31-38 column 9).

However, Davis et al ('005) does not suggest the silicon carbide single crystal is grown with an atmosphere gas that surrounds the growth crucible containing a silicon gas.

In the analogous art, Hung Chi Chang et al ('415) disclose a method for preparation of single crystals from the vapor phase of compounds that decompose silicon carbide.

Hung Chi Chang et al ('415) further disclose in a furnace of growing single crystals of silicon carbide, a cylindrical vessel constructed to contain a charge of material selected from the group consisting of at least one of the group consisting of silicon carbide and mixtures of silicon and carbon. (See lines 47-55, column 11).

Hung Chi Chang et al ('415) further disclose a thin walled vessel is disposed at the center of a hollow cylinder wherein charge of a raw material surrounds the cylinder. The raw material can be silicon carbide, a mixture of elemental silicon and carbon, or both. Hung Chi Chang et al ('415) further teach the raw material is heated in order to sublime silicon and carbon or silicon carbide as a source of vapor, and silicon vapor surrounds the cylinder. (See lines 19-32, column 3).

It would have been obvious for one of ordinary skill in the art to modify method of Davis et al. ('005) by including an atmosphere gas surrounding the growth crucible contains a silicon gas in order to reduce the amount of crystalline defects in the Silicon Carbide single crystal, as suggested by Hung Chi Chang et al ('415).

Davis et al ('005) as modified, still does not teach vapor pressure of the silicon gas that surrounds the growth crucible continuously maintained to be higher than that of the silicon gas in the gas sublimated from the silicon carbide raw material in the growth crucible and that in the growth crucible maintained substantially equal to or higher than equilibrium vapor pressure of the silicon gas contained in the sublimated gas.

In the analogous art, Shiomi et al ('797) teach a method of making a silicon carbide single crystal. Shiomi et al ('797) teaches a graph, which vapor pressure of silicon is higher than that of SiC_2 or Si_2C occurring during the generation of SiC. (See lines 33-37, column 2, and figure 5)

Shiomi et al ('797) further teaches the partial pressure of silicon is capable to be adjusted. (See lines 13-15, column 3)

It would have been obvious to one of ordinary skill in this art at the time of applicants' invention to modify method of Davis et al ('005) by adjusting silicon gas vapor pressure that surrounds the growth crucible continuously maintained to be higher than that of the silicon gas in the gas sublimated from the silicon carbide raw material in the growth crucible in order to enhance the silicon carbide forming speed, as suggested by Shiomi et al ('797).

Claims 3, 5-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Davis et al (US 4,866,005) in view of Hung Chi Chang et al (US 3,275,415) and Shiomi et al (US 6,193,797) as applied to claim 1 and further in view of Shigeto et al. (US 2001/0004877)

Combined teachings of Davis et al ('005), Hung Chi Chang et al ('415), and Shiomi et al ('797) disclos using an outer crucible to surround the growth crucible with a space left there between (See lines 47-55, column 11; Hung Chi Chang et al ('415)).

Combined teachings of Davis et al ('005), Hung Chi Chang et al ('415), and Shiomi et al ('797) also teach evaporating the silicon raw material in the space to

thereby form a silicon gas serving as the atmosphere gas surrounding the growth crucible. (See lines 55-57, column 6; lines 30-34, column 7; Davis et al ('005)).

Combined teachings of Davis et al ('005), Hung Chi Chang et al ('415), and Shiomi et al ('797) further teach the silicon raw material is in solid form. (See lines 7-15, column 2)

However, they do not teach continuously feeding a silicon raw material from outside into the space. They also do not teach the silicon raw material size, feed rate, and the amount of gas pressure surrounding the growth crucible of SiC.

In the analogous art, Shigeto et al ('877) teach a method for producing silicon carbide single crystal wherein a silicon raw material is allowed to continuously react with a carbon raw material to generate gas from which a silicon carbide single crystal grows. (See paragraph [0003]). Shigeto et al ('877) further disclose continuously feeding a silicon raw material from outside into the space (See abstract and paragraph [0018])

Shigeto et al ('877) also discloses the silicon raw material in solid form is in a form of powder constituted by particles having a diameter of 0.2 mm to 5 mm. (See paragraph [0045])

Moreover, Shigeto et al ('877) teach the silicon raw material is fed at a rate of 0.1 mg/s to 5 mg/s that partially falls in the range of 0.5 to 20 mg/second.

Furthermore, Shigeto et al ('877) teach a position within the space to which the silicon raw material is fed has a temperature regulated to at least 1,900° C. (See paragraph [0018])

Also, Shigeto et al ('877) teach production of a silicon carbide crystal can be carried out by setting a total pressure (which is substantially as the same as the total pressure (which is substantially same as the total pressure in the reaction crucible and the raw material) of the production apparatus from a high pressure reaction to a level slightly higher than the normal pressure, i.e., within the range of (0.01 to 1,000) x 133 pa. especially, to efficiently generate reactive gas, (1 to 300) x 133 Pa is preferable (See paragraph [0052]).

It would have been obvious to one of ordinary skill in this art at the time of applicant's invention modify teaching combination of Davis et al ('005), Hung Chi Chang et al ('415), and Shiomi et al ('797) by including a continuous feeding stage of silicon raw material from outside into the space between outer and growth crucible in the SiC production method and apparatus of Davis et al ('005) and Hung Chi Chang et al ('415) in order to improve efficiency, quality, and production rate of SiC.

Claims 11 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Davis et al (US 4,866,005) in view of Hung Chi Chang et al (US 3,275,415), Shiomi et al (US 6,193,797) and Shigeto et al (US 2001/0004877) as applied to claims 3, 5-10, and further in view of Vodakov et al (US 6,428,621).

Combined teachings of Davis et al (US 4,866,005), Hung Chi Chang et al (US 3,275,415), Shiomi et al (US 6,193,797) and Shigeto et al (US 2001/0004877) disclose all the claim limitations of a method for producing a silicon carbide single crystal as discussed above, but do not teach growth rate of the silicon carbide single crystal is

1mm/hour or more, also, do not teach the silicon carbide single crystal exhibits a micropipe density of 10,000 $micropipes/cm^2$ or less.

In the analogous art, Vodakov et al ('621) disclose a method to produce low defect density silicon carbide (SiC) crystal by using a sublimation technique for growth of SiC crystal. (See abstract)

Vodakov et al ('621) further disclose the axial temperature gradient, i.e., the gradient between the source and the growth surface, is in the range of 10°C to 50°C per centimeter, Yielding the desired normal growth rate between 0.4 and 1.5 millimeters per hour. (See lines 42-46, column 8). Vodakov et al ('621) further discloses a SiC material is provided with a low defect density, defects including both dislocations and micropipes. The defect density in the grown SiC is less than 10,000 per square centimeter, preferably less than 1000 per square centimeter, more preferably less than 100 per square centimeter. (See lines 36-40, column 2)

Therefore, it would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify combined teachings of Davis et al (US 4,866,005), Hung Chi Chang et al (US 3,275,415), Shiomi et al (US 6,193,797) and Shigeto et al (US 2001/0004877) by determining the growth rate and micropipe density of SiC in silicon carbide production method in order to control the speed of the growth production for improve the efficiency of the method step and improve the quality of the silicon carbide.

Allowable Subject Matter

Claims 16-18 are objected to as dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

The prior arts of record fails to teach or suggest an apparatus for producing a silicon carbide single crystal with having means for continuously feeding such as any screw feeding, extruding feeding, or vibration feeding apparatus to feed silicon raw material from outside into the space left between outer crucible and the growth crucible, as defined in claim 16. The closest prior art of Davis et al (US 4,866,005), Chang et al (US 3,275,415), Shiomi et al (US 6,193,797), and Vodakov et al (US 6,428,621) are described above. These references do not teach or suggest means for continuously feeding a silicon raw material from outside into the space left between outer crucible and the growth crucible.

Response to Arguments

Applicant's arguments filed on 05/04/2007 have been fully considered but they are rendered moot in view of the new ground of rejection.

Remarks

Applicant's amendment necessitated the new ground (s) of rejection presented in this office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP 706.07 (a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136 (a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Seyed Masoud Malekzadeh whose telephone number is 571-272-6215. The examiner can normally be reached on Monday – Friday at 8:30 am – 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Yogendra N. Gupta can be reached on (571) 272-1316. The fax number for the organization where this application or proceeding is assigned is 571-272-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published application may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business

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